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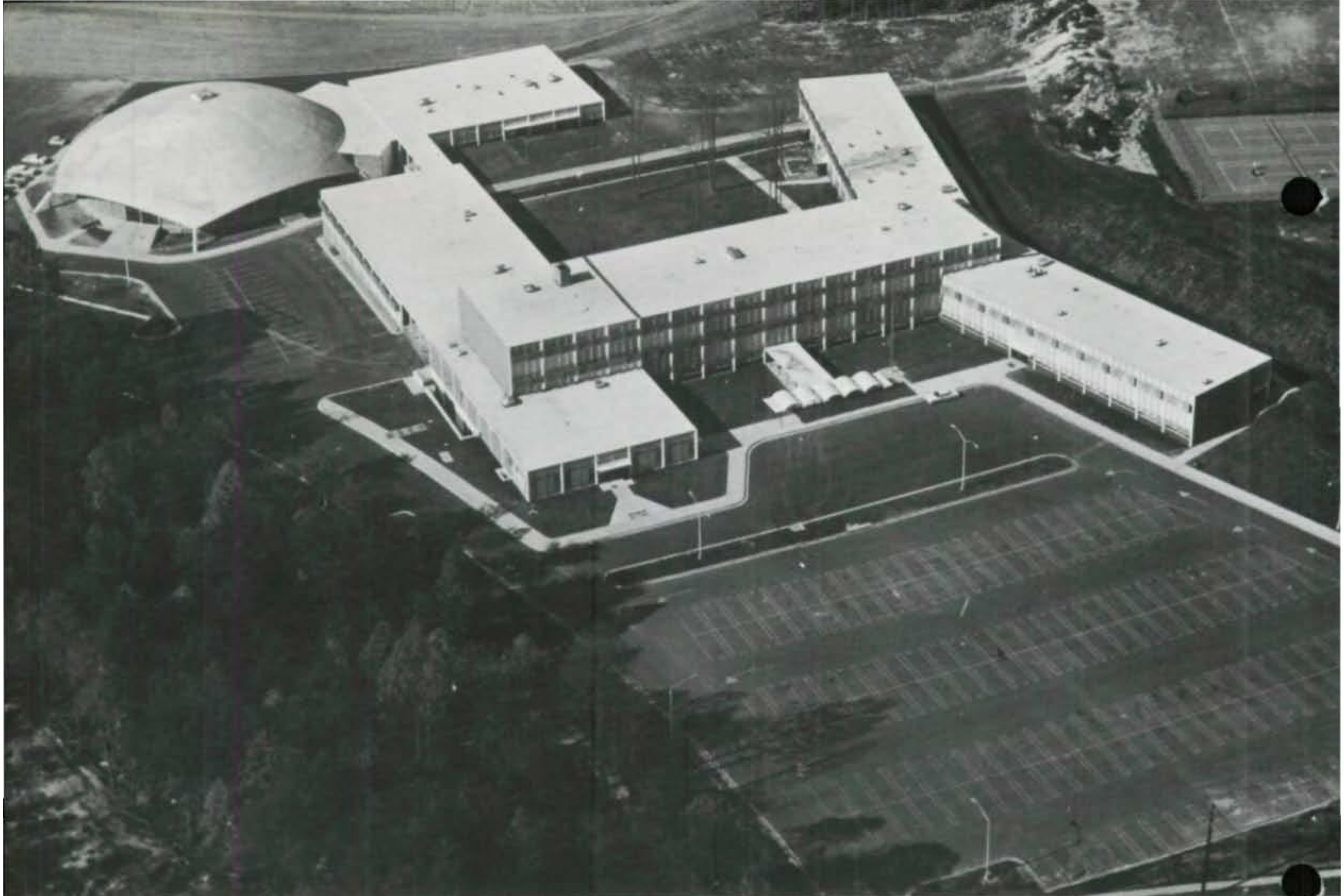
MODERN STEEL CONSTRUCTION



GEODESIC DOME WINS BIDDING COMPETITION

R. Buckminster Fuller's brainchild, the geodesic dome, has been getting a practical workout in a host of structures today — among them, the Union Tank Car Company roundhouse at Baton Rouge, Louisiana, and the observatory at Mt. Washington in New Hampshire. Now a new one has been added to the list. It soars over the Physical education facilities at Walt Whitman High School in Bethesda, Maryland.

The dome solved some fundamental space problems, turned out to be less expensive than the bid for a conventional gymnasium, and the whole project came into being in rather a unique way.

To begin, the firm of McLeod and Ferrara, Architects, A.I.A., was awarded the contract to design the school, in toto. When the award was made, the superintendent of schools, Dr. C. Taylor Whittier, asked the architects to try and develop a better solution for physical education facilities indoors. As time wore on, the architects became more and more interested in using a geodesic dome to break out of the conventional, rectangular mold for gymnasiums. But it became increasingly apparent that the school board could not venture into untested territory without a clear idea of costs. And a true picture of costs was virtually out of the question unless comparative bids were made on the conventional gym vs. the geodesic field house. And that would take money.

Since such a study might benefit school construction throughout the nation, the board and the architects went to Educational Facilities Laboratories and its president, Harold Gores. EFL proved a willing and enthusiastic sponsor, and after several standard-setting sessions among all parties involved, funds were advanced, and the project began to roll.

One of the first things McLeod and Ferrara did was to retain Synergetics, Inc., of Raleigh, North Carolina — the firm that Fuller established to carry out the design of his geodesic structure. James W. Fitzgibbon, T. C. Howard, and J. F. Barnwell of Synergetics worked closely with the architects and with J. Gibson Wilson, consulting structural engineer on the job.

According to the architects' report, published by EFL, "The seemingly simple question of establishing the size of the dome structure was one of the first problems tackled. Criteria established for the comparative study required that space and activity areas be as nearly identical as possible, and that total aggregate space be nearly the same.

"The conventional gymnasium was designed as a two-floor structure, with playing areas above and showers and lockers below. Floor area for the two levels came to 31,586 square feet.... The geodesic field house, as finally designed, contains 35,800 square feet, or some 4,200 square feet more than the gymnasium gross floor area.

"From the many design studies and cost analyses made by Synergetics, Inc., for the dome superstructure, the most practical and economical type appeared to be the combination of a structural steel framing system, covered with a gypsum roof deck and composition roof covering.

"The structural steel framing was left exposed on the underside of the roof, thus giving a honeycomb effect to the dome ceiling. This arrangement, creating a whole series of coffers at the ceiling, together with the use of acoustical panelboard as forming for the gypsum deck, will help offset some of the acoustical difficulties inherent in a hemispherical shape."

At this point, eight contractors were asked to bid on the school as a whole, with a special take-out on the gym and field house, itemized to show exact differences. Merando, Inc., of Washington, D. C., was low bidder and won the job. Its comparison between gym and field house resulted in a $6,087 saving for the field house at a total cost of $583,674.

It should be explained that three of the eight contractors estimated that the field house would be more costly than the gym. Despite this, the architects and EFL were encouraged enough to believe that costs would be lower for some future geodesic dome project that utilized steel in this way.

Thus the field house proved a success in saving the school board money and delivering more usable interior space. Was it a success in other ways? The answer seems to be, yes. For example, while the playing floor itself is somewhat smaller in the field house than it would have been in the gym, the large side and rear areas of the raised deck around the room permit many group activities to be carried on simultaneously.

In addition, the field house provides seating for 1,000 more spectators, and can accommodate a total of 3,500 persons when the area is converted to auditorium use. One of the primary advantages from EFL's point of view is the fact that interior space is unmarked by structural supports. As it reports:

"Whatever barriers are placed within the structure can be dictated by the physical education program, not by the need for holding up the roof. The mutable interior space of the dome offers freedom of movement for both program and occupants.

"Whatever the nature of physical edu-

A Study in Patterns as the 8B10 Geodesic Grid Members Near Final Erection.

cation is in this century and the next, the dome should be adaptable enough to accommodate it."

Highlights of the dome design: because the dome is rather a complicated structure, Synergetics' staff engineer, Dr. M. E. Uyanik, agreed to explain its design and outstanding features. The following are Dr. Uyanik's comments.

"The structure is a spherical dome with a fine geodesic grid framing supported by a ring of columns and a tension ring at the column tops. The frame extends into five edge arches constituting the edge boundaries of the geodesic framing. These arches are, in turn, supported by five piers extended to the spread footings connected by tie rods; thus constituting a pentagonal foundation layout.

"A 2"-thick structural gypsum deck on bulb tees, cast on 1¼" form boards, provides insulation as well as forming a thin shell that supports the dead load of the built-up roofing and all other live loads, including the wind stresses above the tension ring.

"The gypsum deck was poured out of a gyp-concrete mix with a guaranteed compressive strength of 1,000 psi. This was reinforced with 10-gauge wire mesh increasing in thickness from 2" to 3". There was an additional increase in steel reinforcing to provide for the boundary bending stresses at the tension ring level. Making the gypsum deck a part of the structural system reduced the structural requirement of the steel geodesic framing (resulting in considerable economy.)

"The geodesic steel framing, due to the fineness of its grid, was analyzed on the theory of membrane behavior, with axial stresses computed from components of the membrane stresses within the effective area of each steel framing member. All the members of the steel geodesic grid are of one size (8B10), since change in stress from zenith to boundary is very small. Any change in member size would have resulted in additional cost for detailing, and in erection procedures.

"The most complex problem of this framing was encountered at its boundaries, where members of the dome framing were connected to five edge arches. Stresses in the arches and connecting framing members are extremely complicated, due to the necessary requirement of their deformation compatibility. The solution of this problem was an iteration process used by approximately equating the deformations of framing members to those of the arches at their connections.

"Loading compiled with the Maryland building code of 25 psf live load and a wind load of 25 psf (corresponding to a 100 mph wind pressure, or suction).

"Except for the geometry of the geodesic dome framing (which was done by a digital computer), all the analysis and design calculations were carried on a desk calculator. Design specifications of AISC governed all the design of steel parts; and of ACI Building Code for Reinforced Concrete Design for all concrete work."

Architects were McLeod and Ferra.

The Circular Space Arrangements Provides Side and Rear Areas so That Many Group Activities Can Occur Simultaneously.